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Feeding Trials with Animals

INCLUDING

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II. COTTON-SEED MEAL AS A HORSE FOOD.
III. COTTON-SEED MEAL FOR PIGS.
IV. COTTON-SEED MEAL FOR CALVES.
V. FEEDING SKIMMED MILK TO LAMBS.
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VII. A SYSTEM OF FEEDING YOUNG CALVES.

ISSUED BY THE
NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION
RALEIGH, N. C.

BULLETIN NO. 109

OCTOBER 15, 1894
324

Publications will be sent to any address in North Carolina upon application.

N. C. COLLEGE OF AGRICULTURE AND MECHANIC ARTS.

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RALEIGH, N. C.

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BY F. E. EMERY, AGRICULTURIST.

I. THE EFFECT OF COTTON-SEED HULLS AND MEAL AS CATTLE FOOD.

Cotton-seed hulls form about half the weight of cotton seed. They are hard and dry, and are usually covered on the outside with a short fuzzy lint. Hulls from poorly cleaned or green seed may be quite rich in food from broken kernels left in the hulls. Reference is here made to commercial hulls only as they have been purchased for experimental use at various times. There are several points in their favor, however, especially convenience of handling and cheapness. They form a handy medium to dilute condensed food, and give that extension to the animal stomach, especially to ruminating animals (cud-chewing), which is regarded so essential to good healthy digestion.

Cotton-seed meal is the ground residue, or cake, that is left after expression of the ground and steamed kernels from which the hulls have been separated. It is a bright yellow meal with a sweet nutty flavor which is pleasant to the palate. Some samples contain brown or black specks from hulls ground into the meal. This is either an accidental impurity or an intentional adulteration. Cotton-seed meal deteriorates with age and becomes discolored. It is probable that feeding this aged meal, in which chemical changes have taken place, is the cause of the prejudice against its free use. Fresh cotton-seed meal has been fed with the utmost freedom to some experimental

stock, with good effect, and no visible harm has resulted. The meal is poor in carbohydrates, starch, sugar, etc., but rich in fat, and is, perhaps, the richest nitrogenous by-product known which can be utilized as cattle food. It is so rich in this costly part of cattle food that it needs to be mingled with some coarse article which can supply carbohydrates to balance the protein or albuminous part of the meal, so that the animal may use the foods economically. Too much protein is too expensive, and too little is wasteful of the carbonaceous food material used. There must be a certain definite ratio existing between these different classes of foods available to the uses of the animal organism in order to perform its functions to the best advantage. To meet the requirements of our domestic animals in this respect, the German standards have been devised. They do not apply exactly to American needs, and are especially at fault with these by-products under discussion.

The foods best suited to balance cotton-seed meal are corn silage, straw of the cereal grains, corn stover (the stalks after the ears are harvested), poor hay, shucks, etc., all rough cattle foods, and cotton-seed hulls. Stock can be induced to eat these foods for the sake of the meal which can be mixed with them. The cotton-seed hulls can thus be reunited with the meal, with great advantage to the cattle-feeder, after the oil has been extracted. The hulls are the handiest of all to mix and feed, and, when supplied at a price lower than straw, are a good substitute for it as a bulky base to supply carbohydrates in order to balance the protein of the cotton-seed meal.

Feeding cotton-seed hulls and meal together has come to be a regular practice for fattening beeves in the vicinity of oil-mills, and is in process of extension to other localities. Stock fatten very readily on the combination of hulls and meal mixed in proper proportions. What these proper proportions should be have scarcely more than been guessed at in ordinary practice. The German standards, and the usual calculations based upon them, do not give reliable ratios with these foods, and only a few practical feeders, up to this time, have come very near the truth. This Station has been engaged upon the investigation of this matter, together with other questions relating to cattle foods and animal nutrition. Definite proportions between hulls and meal have been digested by animals under experiments with successive trials of rations richer in cotton-seed meal, until a point has been reached beyond which, except, perhaps, in some special cases, it is believed that meal cannot be much greatly increased without incurring financial loss.

We have conducted careful digestion tests, and have determined the amounts actually digested in various combinations. Beginning first with hulls fed alone, then adding meal carefully, the proportions were increased in the successive rations fed. Comparing the results with calculated rations, the data obtained have brought this subject to such a degree of accuracy that feeders may expect reasonable success in feeding stock on cotton-seed hulls and meal, according to the object sought.

The chief rations subjected to digestion are here briefly reviewed, and some of the more practical points noted. Every statement below made is substantiated by feeding trials, reports of which have been or will be made. References are to Technical Bulletins 3 and 4, and to Bulletins 81, 90, 93, and 97.

Result of Feeding Cotton-seed Hulls and Meal.

1. Cotton-seed Hulls Fed Alone.—These have been fed alone to four animals and the amounts digested carefully determined. At the Texas Station also, hulls were digested by six steers (Bulletin 15). As a summary of the whole matter it may be stated the hulls do not furnish food sufficient to support life. Reference here is only to ordinarily well cleaned hulls.

*2. Cotton-seed Hulls and Meal—First Ration** (No. 2 of Table).—Hulls and meal were fed and eaten in the proportion of 7 of hulls to 1 of meal. This maintained the weight of the nearly dry cow, which was producing about 20 ounces of milk daily. This cow weighed approximately 950 pounds. This may be termed a maintenance ration. The nutritive ratio was 1:10.8. This ration gave about 1 pound of digestible protein, 1.22 pounds digestible fat, and 7.59 pounds digestible carbohydrates.

3. Cotton-seed Hulls and Meal—Second Ration (No. 3 of Table).—Hulls and meal were fed in proportion of 6 to 1. They were eaten in the proportion of 5½ to 1 by two steers. The nutritive ratio was 1 to 9.7. Six other steers were fed on this ration and all ate at the rate of 5¼ to 1 for 20 days. For this period the gain was 1 pound per day for each 1,000 pounds live weight of the eight steers.

4. Cotton-seed Hulls and Meal—Third Ration (No. 4 of Table).—Cotton-seed hulls and meal were fed, in the proportion of 4 to 1, to the same lot of steers as were used for the second ration. The nutritive ratio digested by two of the steers was 1:7.5. The proportion eaten of hulls to meal was 3⅔ to 1. These two steers were prepared for market before this period began, and one maintained his weight, whilst the other lost The other six steers gained at the rate of 1.09 pounds per day and per 1,000 pounds live weight. The eight steers consumed 18½ pounds of cotton-seed hulls and 4⅞ pounds of cotton-seed meal per day and per 1,000 pounds live weight.

5 Cotton-seed Hulls and Meal—Fourth Ration (No. 5 of Table).—Hulls and meal were fed in ratio of 3 to 1 for 18 days from time of receiving the steer. There was a loss of weight for six days, caused by change of location. The feed overcame the loss, and the steer gained weight for 12 days, but only exceeded original weight, at the end, as much as the weight of the water drank toward the end of the feeding exceeded the weight drank during the early part of the period. This ration was not fed long enough to establish a rate of

*Technical Bulletin No. 3, N. C. Experiment Station.

gain, after making up for the loss due to change of location. Nutritive ratio 1:5.96. Another steer being fed 41 days on this ration, left a little waste hulls at wide intervals, and gained 1.16 pounds per day and per 1,000 pounds live weight.

6. Cotton-seed Hulls and Meal—Fifth Ration.—Rate of feeding 2.8 to 1. Consumed as 3 to 1. Nutritive ratio 1 to 5.13.

7. Cotton-seed Hulls and Meal—Sixth Ration (No. 6 of Table).—Fed cotton-seed hulls and meal in the proportion of 2 to 1. Feeding as in former trials was close to the limit of appetite. No waste. Nutritive ratio 1:4.27. Fed to one steer 13 days produced a gain of 5 pounds per day, or 4.4 pounds per 1,000 pounds live weight. Fed to another steer 56 days, produced an average gain of 2.43 pounds per day, and per 1,000 pounds live weight, allowance being made for excess of water in previous period. This steer ate 18 pounds of hulls and 6 pounds of meal, except on the 38th day, when $4\frac{1}{4}$ pounds of waste was left. This was 16 pounds hulls and $5\frac{1}{3}$ pounds meal per day, and per 1,000 pounds live weight, waste being neglected. After feeding for 56 days the hulls were increased to $22\frac{1}{2}$ pounds and the meal reduced to $7\frac{1}{2}$ pounds. This was fed for five days. Then both were increased to 27 and 9 pounds per day for 17 days. The meal was all consumed except a small amount mixed in the hulls one day. There were 24.36 pounds of hulls consumed. So the proportion eaten was 2.8 to 1. The steer gained for this time 2.66 pounds per day and per 1,000 pounds live weight.

8. Corn Silage Alone (No. 7 of Table).—This was fed alone to a heifer, about $2\frac{1}{2}$ years old, and not a very hearty eater.

9. Corn Silage and Raw Cotton Seed (No. 8 of Table).—Corn silage and raw cotton seed were fed to same heifer and following the corn silage alone.

10. Corn Silage and Roasted Cotton Seed (No. 9 of Table).—Corn silage and roasted cotton seed were fed to the heifer "Spot" and "Steer No. 3" of about same age as above.

11. Corn Silage and Cotton-seed Meal (No. 10 of Table).—Corn silage and cotton-seed meal were fed to two steers about three years old. One steer, the smaller, gained most. For 14 days the gain was 4 pounds per day, calculated to 1,000 pounds live weight. See Bulletin 93, Article II, p. 41, for statement of whole period and rations for the whole time.

NOTE.—In feeding these rations in definite proportions, the amount to feed any given animal can be found by testing the appetite of that animal. While the proportions are kept the same, these rations are good for any amount that can be eaten regularly.

TABLE I.—Rations and Amounts of Digestible Nutrients Fed to Stock, and the Result.

Number of Ration.		Total dry matter. Per 1,000 pounds weight.	Pounds of Digestible Nutrients Consumed per Day and per 1,000 lbs. Live Weight.					Result.
			Protein.	Carbo-hydrates.	Fat.	Nutritive Substance.	Ratio 1 to	
1	Cotton-seed hulls fed alone	10.30	.034	3.495	.4378	3.967	135.	Weight lost.
2	Cotton-seed hulls and meal fed in proportion of 7 to 1	22.80	1.001	7.688	1.241	9.930	10.8	Wt. maintained and yield 18.6 of milk.
3	Cotton-seed hulls and meal fed in proportion of 6 to 1	21.19	1.067	7.62	1.006	9.70	9.5	Gain 1 lb. per day, and per 1,000 lbs. wt.
4	Cotton-seed hulls and meal fed in proportion of 4 to 1	20.55	1.47	8.192	1.092	10.765	7.5	Gain. (See Bulletin 93, p. 18, 6th period.)
5	Cotton-seed hulls and meal fed in proportion of 3 to 1	21.466	1.875	8.645	.992	11.512	5.9	
6	Cotton-seed hulls and meal fed in proportion of 2 to 1	24.234	2.805	8.944	1.264	13.013	3.9	
7	Corn silage alone	10.27	.264	4.918	.173	5.355	20.	Wt. maintained
8	Corn silage and raw cotton seed, $2\frac{3}{4}$ to 1	12.50	.942	4.945	1.455	7.342	9.16	Wt. maintained
9	Corn silage and roasted cotton seed, 3.5 to 1, nearly	13.36	.723	5.23	1.31	7.26	11.77	
10	Corn silage and cotton-seed meal, 8 to 1	22.98	2.866	11.98	.923	15.764	4.98	Gain 4.00 lbs. daily per 1,000 lbs. wt.

Rations of Hulls and Meal Recommended for Specific Objects.

1. For Maintenance.—Where it is desirable to feed an animal just sufficient to maintain it without loss, the following rations may be used:

Hulls from rather green seed may be fed alone, the particles of seed kernels remaining accidentally with the hulls being counted on for maintenance, or, perhaps, even for slow fattening. Dependence, of course, is placed on the amount of kernels left in the hulls. With well cleaned hulls, however, some cotton-seed meal must be used, depending somewhat on the animals fed. With the cow weighing 950 pounds, one pound of meal to every seven pounds of hulls has been shown to maintain the weight and produce about 20 ounces of milk per day. Probably 8 or 10 pounds of hulls to 1 pound of meal,

when fed in quantity (as much as can be eaten clean), will support life and maintain the weight of neat stock.

2. For Slow Fattening.—Rations ranging from 7 of hulls to 1 of meal down to 5 or 4 to 1 may be used, depending on the animals fed and skill of the feeder. Each animal should be provided with just what it can consume and no more. With thrifty stock 4 to 1 will produce very good growth, or in mature animals it may be counted on to fatten in from 80 to 100 days.

3. For Quick Fattening.—Rations for making good beef quickly may range from 4 to 1 down to 2 to 1, or even 1.5 to 1, as we have fed steers successfully on the latter ration. For feeding half-fat cattle from 30 to 45 or 60 days, these last rates are well calculated to increase the body weight. But it is doubtless a good plan to heed the German standard and feed the wider ratio at the last, in order that more of the digestible food may be fixed as muscular tissue.

4. For Milk.—For the deepest flow of milk, we consider it a doubtful practice to feed exclusively on hulls and meal, though both may be prominent articles in the ration. We prefer to fill up a cow on more digestible food than hulls. If cotton-seed meal is fed in quantity sufficient to support a cow giving a large flow of milk, it may occasion danger to her health, as it certainly does where fed to pigs and calves in like manner. When a cow has passed about four or five months of gestation, and the flow of milk has greatly diminished, she may be put on a ration of hulls and meal, which may be varied from 4 to 1 to as much as 7 or 8 to 1 of hulls to meal until she has dried off. This will support the cow well. It would be well all this time, however, to be feeding once per day some hay, stover, straw, or let her graze part of each day. For two or three weeks before calving, the cow's ration should be changed by substituting a succulent diet or bran for the cotton-seed meal. A week before calving, if not already affected by the succulent diet, the cow should be thoroughly purged with Glauber's or Epsom salts, in one pound dose. Care should be exercised to see that the bowels remain loose, if not, repeat the dose at intervals, as needed, until the cow has come to her full yield of milk after calving. By a little care, a feeder will thus save losses of stock and veterinarian's fees.

5. For Other Stock.—To other than ruminating animals, the use of either cotton-seed hulls or meal is yet of doubtful expedience. Hulls are too bulky for horses, yet cotton-seed meal may often be fed, in *small* quantities, to good advantage with the usual wide ratio rations. Its action, however, on the nervous system is yet untried, so far as we are informed, and it would only be safe as a small part of a ration to be used, much as linseed meal or flax seed is sometimes used. This meal, in small quantities, is not so laxative as linseed meal.

II. COTTON-SEED MEAL AS A HORSE FOOD.

Cotton-seed meal is so rich in protein that it is one of the best foods with which to "balance" rations. It has become a standard food for cattle and sheep. Why not use it for horses and mules? Thousands of work animals in North Carolina can be better and more cheaply fed if cotton-seed meal is used for part or all the grain. No experiments that we know of had been made when we began to agitate the question, though some cotton-seed meal feeding to such stock may have been done.

Two old horses were secured for the purpose of ascertaining the effect of cotton-seed meal in a ration. They were fed a good ration for ten days, consisting of clover chaff threshed out with crimson clover seed, corn meal and ship-stuff. One horse gained and one lost weight on this ration, while both were kept at usual work. No. 1 gained 1.7 pounds daily, and No. 2 lost .97 pound daily. The ration fed during this period to both horses is given as No. 1 below.

During the second period both horses gained weight—No. 1 at the rate of 1.6 pounds per day, and No. 2, 4.1 pounds; or, if the apparent loss in weight of No. 2 during the first period were due to reduced stomach contents, consequent on change to better than previous ration, and this gain distributed over the two periods, it would be equivalent to 1.56 pounds per day. The daily weights show irregularity and falling back during the first period; but when two pounds of cotton-seed meal had replaced two pounds of corn meal and ship-stuff of the ration in the first period, there was an almost regular advance in body weight.

After the first two periods the same chaff was continued two days and the grain changed by reducing corn and ship-stuff one pound each and increasing the cotton-seed meal one-half pound. Then, with the grain fed regularly as thus changed, timothy hay was fed in place of the chaff. Horse No. 1 refused the hay, and ate only what meal he could pick off, leaving hay, saliva and meal in excess of the hay fed. He was discarded after four days of this kind of feeding. Horse No. 2 was continued eight days, but did not eat the hay well, although he nearly held his weight. Neither horse showed any symptoms to indicate that the cotton-seed meal disagreed with them, but both objected to late-cut timothy hay after crimson clover straw and chaff.

The rations fed and consumed were as follows for both horses during two periods of ten days each, and also what was fed during the third period:

TABLE II.—Rations containing Cotton-seed Meal fed to Horses, and Consumed during various Periods.

	FIRST PERIOD.		SECOND PERIOD.		THIRD PERIOD.
	Pounds Fed.	Pounds Eaten.	Pounds Fed.	Pounds Eaten.	Pounds Fed.
Smith's Horse.					
Clover Straw (chaff)	18.	17.8	17.	16.44	9
Ship-stuff	5.	5.	4.	4.	2
Corn Meal	5.	5.	4.	4.	2
Cotton-seed Meal	----------	----------	2.	2.	2½
Horse No. 2.					
Clover Straw (chaff)	18.	16.46	17.	17.0	9
Ship-stuff	5.	5.	4.	4.0	2
Corn Meal	5.	5.	4.	4.0	2
Cotton-seed Meal	----------	----------	2.	2.0	2½

The timothy hay would have been fed *ad libitum* if horses had eaten it, and the grain also raised to make a fairly balanced ration with it. The only object in view, however, was to study the effect of feeding the cotton-seed meal.

This refusal of timothy hay is only an additional indication of the false value placed on this hay. It is far from being worth as much as many other kinds of grass or of mixed grasses. Previous to this feeding trial, we have received one report of one pound cotton-seed meal daily, having been fed to mules with other grain.*

Later in reply to an inquiry, Mr. E. d'Alinge, of the Biltmore estate, writes that he has for some time been feeding two pounds per day, except Sundays, to work-horses and mules. The ration, with cotton-seed meal in this case, being as follows: 13 to 15 pounds cut hay and finely cut corn fodder; 4 pounds wheat bran; 2 pounds cotton-seed meal; 6 pounds corn meal. The whole mixed together. On Sundays a change is allowed to whole grain, oats and corn, and uncut hay

This experience should be worth a great deal to owners of work stock. There is no food so rich in albuminoids that can be obtained so cheap as cotton-seed meal, and nothing else will go so far for a given weight in balancing rations of coarse foods as hay, stover, pulled fodder, straw, etc. No one need work a poorly fed horse, mule or steer if he will only heed this experience and profit by the directions already given in a previous bulletin (No. 106).

III. COTTON-SEED MEAL FOR PIGS.

[See Page 433 and following for detailed description. Supplied upon application to the Director.]

While two native pigs were being fed on skim-milk, one was put on a ration of cotton-seed meal and wheat bran; the other on corn meal and bran. After about six weeks feeding on small quantities

*Bulletin 106, p. 317.

of these meals, they were increased to two pounds per day, and the cotton-seed meal apparently caused the pig to which it was fed to pine until food was refused. After a change to corn meal was made, the pig recovered. The pig which was fed on the corn meal throve all the time. Later a little more cotton-seed meal was fed, but, rather than risk the loss of the pig, it was dropped. After feeding a period on corn meal, both were slaughtered and comparisons of live and dressed weights were made. The pig which was fed on cotton-seed meal weighed twenty-five pounds less than the other, and dressed 71.21 per cent. of live weight. The pig fed on corn meal dressed 73.68 per cent. of live weight.

It is shown that these native pigs were fed at a loss of the bran and meal fed, excepting the manurial value, counting the skim-milk as worth two cents per gallon. If the grain was charged for, the skim-milk brought less than half a cent per gallon.

A summary of a feeding test of pigs on cotton seed and cotton-seed meal, made by the Texas Experiment Station, published since the above feeding was concluded, shows that of three pigs fed raw cotton seed, two died; of eight pigs fed roasted cotton seed, six died; of eight pigs fed boiled cotton seed, two died; and of ten pigs fed cotton-seed meal, five died; of eight pigs fed corn meal, all throve well. The symptoms of the poisoning are given, and also the fact that some older pigs seem to be proof against the poison. Boiling the seed seems to lessen the danger from it.

IV. COTTON-SEED MEAL FOR CALVES.

[See Page 437 and following for detailed description. Supplied upon application to the Director.]

With better methods and practices in dairying, it becomes desirable to raise calves on skim-milk. Where common methods of creaming the milk prevail, the skim-milk is good enough to grow up handsome calves and cows; but with the use of separators, the fat is so thoroughly extracted from the milk that it is necessary to replace it by the use of some convenient by-product containing an oil to replace the fat of the milk. Cotton-seed meal has been suggested for this purpose, but trials of it made at this Station led to results which do not commend the use of this meal as a supplement to separated or centrifugal skim-milk. Of three calves fed on this meal all died, but the death of one was due to licking up or eating sand. The other two are supposed to have been victims of some toxic agent in the cotton-seed meal which powerfully affects the nervous system. This apparently attacked three mature cows, probably causing the death of one.

Linseed meal, though costing too much, is yet the best by-product to supplement centrifugal skim-milk, unless sunflower or peanut cake or meal can be obtained. These products can be made in North Carolina, and the Experiment Station will make tests of them as soon as the cakes or meal and calves can be secured.

V. FEEDING SKIMMED MILK TO LAMBS.

As a means to dispose of surplus skim-milk in dairying, the fattening of young lambs has some promise. An effort was made to try this by using the "culls" of flocks brought to the city market, and which could be vastly improved for the market. A small flock of ten were tried. They were so wild that for the first week or two they would bound around the open pen when they discovered any person observing them; while the presence of a man in the pen was a sure signal for a stampede, up to the day the last one was turned over to the butcher.

These lambs were carefully handled and as much attention as possible given them without keeping them continually frightened. They were given green clover, wheat bran, oats, some corn, and separated milk. Some of the lambs learned to drink the milk readily, and if the whole flock had been tame, doubtless the results would have been far better. The wildness of the lambs caused some of the milk to be often wasted. The lambs were received May 15 and 25th. Four were sent to market June 20th and five August 6th. One died. The latter was weak and poor, and the violent exertions of its fellows, whenever visited by an attendant, combined with the confinement, was probably the cause of death. The cost of lambs and food, aside from milk, were greater than the price received for the same, hence only a negative result was obtained. A further trial will be given if lambs can be found sufficiently tame for the experimental test.

Sheep raisers do not foster their own interests when they allow sheep and lambs to become as wild as were the ones fed at the Experiment Farm, and as some of these remained after weeks of daily association with a quiet attendant.

The amount of food allowed, and either consumed or trodden under foot by these lambs, was as follows:

1,462 pounds of green clover at $6 per ton	$4.386
116 pounds wheat bran at 1 cent per pound	1.16
30 pounds corn at 1½ cent per pound	.375
127 pounds oats at 2 cents per pound	2.54
Total cost	$8.46
Net increase in value of 9 lambs	5.63
Loss	$2.83

917 pounds separated milk were also fed.

Not only was nothing received for the separated milk which was fed, but there was a loss on the other food eaten.

VI. A PIG-FEEDING TEST.

[See Page 440 and following for detailed description. Supplied upon application to the Director.]

During the winter of 1893–'94, two grade Poland-China and two cross-bred Poland-China and Jersey-Red pigs were fed weighed amounts of separated milk (centrifugal skim-milk) and bran, the aim

being to give all the pigs would eat clean. The weight and gain of each pig were determined after nine days. Then the three males were castrated, and after being fed a second period of sixteen days, only one seemed to have been checked in the rate of daily gain. The weighing was discontinued, but the pigs grew well and later on were fed through eleven ten-day periods on a series of rations calculated for a correspondent. The weights of food, average of live weights, and gains by periods were recorded throughout the whole 110 days. These rations consisted of wheat bran, cow-pea meal, and corn meal mixed in different proportions and numbered 1 to 5. Ration No. 1 was fed the first, and No. 2 the second period, and so on. No. 5 was, however, repeated in the sixth period, and No. 4 was fed in the seventh, etc., until all rations were fed twice. Then No. 5 was fed again for the eleventh period. The nutritive ratios and cost of the rations were determined. The food of one (*Black*) was mixed with hot water and allowed to stand from one feed to the next. The food of the mate to Black (*White-Tail*) was mixed with cold water so thin as to be sloppy. The food of one cross-bred pig (*Red*) was given dry. The food of the other (*Spot*) was mixed stiff with cold water. All were allowed water as freely as desired in separate troughs when they seemed to need it, in addition to the surplus separated milk which was fed in proportion to their weight at the end of the last period. Milk and meal were fed three times per day during the first period, then milk twice and meal three times per day for five periods, then only twice per day for both. Summaries have been calculated for the whole of the ten periods. The addition of sufficient cold water to the grain to make the ration sloppy gave the poorest result in gain, while the dry food gave the best result.

As to the result of the feeding, the gain in weight paid for the value of the grain fed, and paid also for the separated milk for the fifty days' feeding, from 1.4 cents to 2.03 cents per gallon. During the last fifty days there was not enough gain in live weight to pay for the grain fed, and consequently nothing was received for the milk.

VII. A SYSTEM OF FEEDING YOUNG CALVES.

[See Page 448 and following for detailed description. Supplied upon application to the Director.]

Milk from many dairy cows is too rich in butter fat to feed to calves. Besides being wasteful of butter, so much fat is not needed and may derange the digestion of the calf.

Average cow's milk contains about 3.5 per cent. fat. This amount of fat being natural to the calf does it no harm. But the calf can thrive on less fat, which may be obtained from some other source than natural mother's milk. The difference in market value between milk fat and such fat as may be supplied, may be so great as to leave a good profit for the feeder.

The substitution of skim-milk and "old process" linseed meal gruel for mother's milk by easy stages is possible, and has been accomplished at the Station with gratifying results. The young calf is taught to drink freshly drawn mother's milk at one to four days old. The gruel is prepared by scalding the meal in water, using one part of meal to seven parts of water by weight. The change is made by feeding one pound less of full milk and adding one pound of skimmed milk and one-fourth pound of the linseed meal gruel at every successive feed, if the calf appears well and digestion is not impaired. Calves should be closely watched and the amount of gruel or food varied to suit the individual. A few ounces of ground oats and good fine hay should be kept within the calf's reach at all times until it eats both, then regular feeds should be supplied the same as of milk and gruel. A little green food may be offered, if possible, or if in summer the calves may be turned into a small shady pasture.

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[The complete bulletin contains thirty-four pages, and the subject-matter can be seen by reference to the table of contents on page 431. Persons who do not receive pages 433-450 can be supplied by making application to DR. H. B. BATTLE, Director, Raleigh, N. C.]

COTTON-SEED MEAL FOR PIGS.

[For a summary of this article, see Page 426.]

The first pigs fed at the Experiment Farm were two boars purchased May 22d, 1891. At the time of purchase the pigs weighed 24 and 26 pounds respectively. They were fed the separated milk (the skim milk which came from the separator), waste from cow mangers, and occasionally green weeds, up to July 20th, when both were castrated. The pigs grew well and were both healthy and strong. The feed was continued practically the same as above until September 15th, the pigs consuming what remained unsold of the milk, and were seldom fed any feed other than waste from cows or weeds from the field up to the latter date. The rates of growth during this period may be noted by weights taken at the several dates noted below:

	May 22d.	June 11th.	July 21st.	July 31st.	Aug. 10th.	Aug. 22d. Av. 3 wts.	Sept. 14th.
No. 1	24	31	64	66	75	82⅓	88
No. 2	26	35	65	66	79	83⅓	91

During September a correspondent enquired about feeding cotton-seed meal to pigs, horses, and mules. There were no experiments then made that we knew of, and hence it was determined to feed cotton-seed meal to one of these pigs. They were separated and given the following daily rations September 15th, 1891, for period I:

No. 1—
- 12½ pounds separated milk.
- 2 pounds wheat bran.
- 4 ounces cotton-seed meal.
- Some green food was given at noon.

No. 2—
- 12½ pounds separated milk.
- 2 pounds wheat bran.
- 4 ounces corn meal.
- Some green food at noon.

No. 1 left some waste for six days and No. 2 for only two days, after which all the food was consumed until the corn and cotton-seed meals were increased October 5th. On this date the milk was dropped in order to have more meal eaten. The rations for 21 days were as follows for period II:

Pig No. 1
- 20 ounces cotton-seed meal.
- 40 ounces wheat bran.
- Green food at noon, consisting of weeds and earth pulled with the weeds.

Pig No. 2
- 20 ounces of corn meal.
- 40 ounces of wheat bran.
- Green food, consisting of weeds, at noon.

These rations were so nearly consumed by both pigs that no waste was left, except on the 14th, 15th, and 16th days two pounds of waste were noticed from No. 1. A mean of the three weights, October 22, 23, and 24, was—for No. 1, 124; No. 2, 130⅔ pounds.

For Period III. the feed was still further advanced to 32 ounces corn or cotton-seed meal and 48 ounces of wheat bran to the respective pigs. This was too much for pig No. 1, and more or less of it was left all the time. Pig No. 2 ate all of his food every day. Subtracting waste taken up from the meal fed, would leave but 2.93 pounds of both cotton-seed meal and bran consumed per day by pig No. 1 during the nineteen days this was fed. Only 48 pounds of green food was given during the first ten days of this period, and none after that time. At the end of this third period of feeding on cotton-seed meal, pig No. 1 was sick and weighed but 113 pounds. Pig No. 2 was eating all of his ration, and had gained to 136 pounds. On the nineteenth day No. 1 was fed corn.

For Period IV. both pigs were fed corn and wheat bran in the proportion of one to two, and from the seventh day 12 pounds of separated milk was fed to each pig. No. 1 gradually recovered his health, and after two weeks ate the whole ration. During the first eleven days the waste amounted to 3.62 pounds daily, which would leave but 2.38 pounds consumed, while during the last eleven days the average consumption was 5.78 pounds. The pigs weighed 122⅔ and 150⅓ pounds respectively at the end of this period.

Period V. was a return to cotton-seed meal ¼, with wheat bran ¾ in the ration for No. 1; and corn meal ¼, with wheat bran ¾ in the ration for No. 2. Twelve pounds of separated milk was fed to each daily. Except for 56 ounces of milk and meal waste from No. 1 during the first days, all was consumed. Then, as the pigs were approaching maturity, and it did not seem desirable to sacrifice pig No. 1, as might be done by continuing cotton-seed meal in his food, both pigs were fed eleven days more in Period VI. on a ration like that for No. 2 in Period V., when they were butchered at the close of Period VI.

Weights of the pigs at the close of the various periods, and dressed weights at the close of the experiment, were as follows:

	Weight before cotton-seed meal was fed.	End of Period I.	End of Period II.	End of Period III.	End of Period IV.	End of Period V.	End of Period VI.	DRESSED WEIGHTS.	
								Pounds.	Per cent. of live wt.
Length of period in days	------	20	21	19	22	10	11	------	------
Pig No. 1	88	------	124	113	122⅔	134.8	146	104	71.21
Pig No. 2	91	------	130⅔	136	150⅓	169.2	171	126	73.68

Feeding this kind of pigs was unprofitable. The cost of the pigs exceeded their value at every step of the feeding, if the separated milk is considered worth two cents per gallon. This, it should be observed, was with well fed native or "piney-woods" stock. The two pigs were fed 3,529½ pounds, equal to 441 gallons, of separated milk, up to September 15th. From that time to December 26th, 1,296½ pounds, or 162 gallons, were fed.

This, at 2 cents per gallon, equals		$12.06
Original cost of pigs, $2 each		4.00
Total cost for pigs and milk		$16.06
Selling price of pigs, 7c. per pound, dressed weight—		
No. 1, 104 pounds, at 7c	$7.28	
No. 2, 126 pounds, at 7c	8.82	
		$16.10

Cost of meal fed, by this statement, would be lost. But a restatement may be made, so that a fair valuation will be placed on the meal, and show what the milk would bring when sold to this kind of hog:

	No. 1.	No. 2.
Cost of pigs	$2.00	$2.00
Wheat bran fed, 297½ pounds, at 1c	2.975	2.975
Corn or corn meal fed, at 1¼c., 56	.60	1.665
Cotton-seed meal fed, at 1⅛c., 77¼	.927	----
	$6.602	$6.64
Value of dressed weight as above	7.28	8.82
Balance to pay for milk	$ .68	$2.18

This is 2.1 gallons for 1 cent, or a little less than ½ cent per gallon.

As the result of feeding cotton-seed meal, it may be stated that 4 ounces were fed per day with 32 ounces of wheat bran for twenty days, and 20 ounces per day of cotton-seed meal with 40 ounces of wheat bran for the following twenty-one days were fed and nearly all consumed by a hearty pig, without faltering; but when 2 pounds per day were fed, the pig refused to eat so much, and became sick on what was eaten, but recovered on a corn diet. This seemed to emphasize that cotton seed and cotton-seed meal is an unsafe food for swine.

Later, the Texas Experiment Station published a bulletin, No 21, on the "Effect of Cotton Seed and Cotton-seed Meal in Feeding Hogs," in which the death of a number of pigs is recorded from effect of eating cotton seed and cotton-seed meal, as follows:

TABLE III.—Result of Feeding Cotton-Seed Meal to Pigs.

FOODS.	1891.		1892.	
	Fed.	Died.	Fed.	Died.
Raw cotton seed soaked	0	0	3	2
Roasted cotton seed	5	4	3	2
Boiled cotton seed	5	1	3	1
Cotton-seed meal	5	5	3	2
Corn only	5	0	3	0

This is a startling mortality, ten out of fifteen pigs fed on cotton seed and meal in one year's experiments died, and seven out of twelve during the next year.

The record of the experiments is followed in the Texas Bulletin by the following statement: "In corroboration of the above results for two years in succession, we have to state further that several times during the past decade the college herd of swine has suffered from attacks of apparently epidemic disease—cause not then understood—the symptoms, both before and after death, agreeing closely with the symptoms noted carefully in later tests. Since the later tests have warned us of a possible cause, we have definitely determined that in case of each and every outbreak in the college herd of swine—three separate times—sickness occurred within a period of ten weeks after the first addition daily of a very small quantity of cotton-seed meal (not cotton seed) to the slop on which the hogs were fed. As above stated, the symptoms are remarkably uniform, and, once seen, an intelligent observer will hardly fail to recognize a recurrence of the trouble.

"The first sign of sickness, appearing in from six to eight weeks after cotton-seed meal is added to the ration, is a moping dullness of the animal with a loss of appetite and tendency to lie apart. Within the course of twelve to thirty-six hours, often within a shorter time, the animal becomes restless, staggering in his gait, breathing labored and spasmodic, bare skin showing reddish inflammation, sight defective, and both the nervous and muscular systems feeble and abnormal in action. The fatal cases all show spasmodic breathing, and in many instances the animal will turn in one direction only—following a fence or building wall so closely as to strike his nose against projections in a vain endeavor to push outward in that one direction which he tries to take. If no fence or building intercept him, he may travel in a circle, large or small, according to the mildness or acuteness of the malady in his particular case. When exhausted by his efforts the animal drops down suddenly, sometimes flat upon the belly, sometimes dropping on his haunches with his fore legs well apart to keep from falling over, almost always with the evidence of more or less acute internal pain. At death a quantity of bloody foam exudes from mouth and nostrils." Dr. Francis, Veterinarian to the Texas Station, found only negative results from post-mortem examinations and from feeding fluid-extract of cotton-seed meal by which he had hoped to concentrate the toxic principle. Under "Comments," closing the Texas Bulletin, we extract the following remarks: "In the tests for 1892, the medium and small-sized shoats * * * were the ones which suffered most; the large-sized shoats * * * resisting its effects and coming safely through." "Some hogs resist the poison and are practically cotton-seed proof." Fewer and later deaths with boiled seed "would indicate that thorough boiling has the effect to lessen danger in the use of cotton seed for hogs."

COTTON-SEED MEAL FOR CALVES.

[For a summary of this article, see Page 427.]

Dairymen have long known that linseed meal will grow calves in good form when fed with skim-milk. Flax is not a common crop in North Carolina or the South, and the linseed oil mills being situated so far North or West, the addition of freight charges to the price of the linseed meal makes it costly for feeding purposes.

But there is an article at hand, cotton-seed meal, which, if safe to feed to calves, or can be so prepared as to take the place of linseed meal, can be fed by Southern dairymen at a cost from two-thirds to three-fourths the cost of linseed meal. To test the availability of cotton-seed meal, which is the richer food, as a substitute for linseed meal, it has been fed to several calves in separated milk with the results detailed below. So far, results do not show that a general change to this meal for calves is desirable.

Cow Calf from Cow No. 17.—Cow and calf received Dec. 13, 1893, on trial. Calf donated by Mr. Chas. Crawford for this experiment. Calf was taken from cow at once and taught to drink warm separated milk. Dec. 17 and 18 one ounce of cotton-seed meal was put in feed for four times. Dec. 24 one and one-half ounces cotton-seed meal were put with each of two daily feeds of six pounds of separated milk. This was continued until the 31st, when the cotton-seed meal was reduced to 1½ ounce on account of waste. On Jan. 7th another advance was tried for that day only. The calf remained bright and active and was growing at the rate of .85 pound per day. Several other trials were made in increasing both the cotton-seed meal and the milk, until from January 16th to 29th inclusive, four ounces of the meal were consumed, with 15 and 16 pounds of milk daily. On the 30th and 31st, the feed was 5 ounces per day of meal and 16 pounds of milk. The total of both milk and meal consumed in January were 433¼ pounds of milk and 7⅛ pounds of meal. The calf gained 32.83 pounds in weight during this month and was fat, bright and active the whole time. The increase of meal was stopped at 6 ounces per day for the first three days of February, then for three days it was 8 ounces. Hay was fed to this and a smaller calf occupying the same stall as needed during January, in half, three-quarter and one pound amounts This calf died very suddenly on the night of February 7th–8th. A post-mortem examination was made by Dr. F. P. Williamson, who reported it as follows: * * * "The subject was female calf aged about two months. We found the brain in normal condition, also heart, pancreas, kidneys, spleen, liver and digestive canal. In the thoracic cavity was found a superabundance of fluid indicative of pleurisy. The pleura in places showed ecchy-

motic patches. The pulmonary tissue was less in volume, having lost something of usilence on manipulation."

Cow Calf "Rioter St. Helier."—The name of this calf indicates its breeding, though its dam was a grade Jersey cow. It was dropped January 9th, 1894, and was kept in the stall with the above calf, and with Polly B. 2d, mentioned below. Began to feed milk on the 14th, and mixture of fresh whole and skimmed milk on the 21st, giving 5 and 5½ pounds a. m., and 4½, 5 and 6 pounds in the evening. During January this calf grew well. In February it gained 40½ pounds, and was bright and active all the time. The whole milk was gradually diminished, and the skimmed milk increased until during the last days of February and four days of March, when about 1 quart of the former and 5.77 quarts of the latter per day was fed, with 4 ounces of cotton-seed meal. A little hay was kept where the calf could get what it would eat. During the first three days of February, 5 ounces of cotton-seed meal were fed in the milk, after which 4 ounces were given and consumed every day except on the 9th, 12th, 13th and 15th, when there was no meal in the evening feed. In all, there had been fed 113 ounces of cotton-seed meal in thirty-two days. This calf was sprightly and active on the 4th, and died during the night of March 4th–5th. Post-mortem examination by Dr. F. P. Williamson resulted in the following report: "All organs were in healthy condition, abomasum contained cheesy mass, measuring nine inches in length by four and a half inches in breadth, and three inches thick, which weighed 31 ounces. Just back of this mass, completely blocking up the pyloric opening of the small intestine, was a quantity of sand about an inch in thickness. That this effectually stopped the passage of food, was shown by the fact that the whole of the intestine back of this was empty."

This calf had been out of the stall for a short time one day, exercising very briskly. She was not known at that time to have swallowed any foreign matter. The stall floor was of clay, bedded usually with hardwood leaves. It is possible that these carried enough sand to the floor of the stall for the calf to have licked up what was found in the stomach. The cheesy mass was the coagulated milk taken at the previous evening feed, and was not regarded as unnatural by Dr. Williamson.

Calf from Cow No. 18.—This calf came with its dam March 6th. It was then about one week old. It was taken from the cow soon after and taught to drink; then skim-milk was gradually substituted for the whole milk, and cotton-seed meal put in the milk. Four ounces per day of cotton-seed meal were put in the milk fed to the calf from March 14th to April 17th. This was not always completely eaten, and often much of it was refused. Eleven to twelve pounds of milk were fed at first, divided into two daily feeds, and this amount was increased to 14 pounds per day on March 27th, and after April 8th to 16 pounds. Hay was kept where the calf could get it if needed. The calf appeared well up to feeding time, April 17th, when it was

found lying down in a convulsion or spasm. Some froth was issuing from the mouth; died before 5 P. M. Post-mortem examination by Dr. F. P. Williamson, who reports as follows: "Calf, aged about two months, showed viscera all in normal condition; cause of death supposed to be toxic effect of cotton-seed meal."

We have also had one death of a cow which was supposed to have been caused from feeding cotton-seed meal scraped from the grain bin, which had not been carefully cleaned at the previous emptying. She was found down in a spasm with foam issuing from the mouth, and died in a few minutes after the stable was opened in the morning.

At two different times, at long intervals, two other cows have shown very decided nervous shocks. In one case the neck was affected and the cow's head was apparently cramped to one side. She could not straighten it, and moved in a narrow circle, becoming very excited in doing so. Recovery was made, but flow of milk was checked. The other cow had paralysis of motor organs, with trembling champing jaws and foaming at mouth. Relief was obtained from a pound of Epsom salts and 1½ ounces of laudanum. These two cases seem to have been due to the effect of cotton-seed meal, possibly from feeding old or damaged meal. Change of diet and omitting the cotton-seed meal from the ration subsequently kept both cows in normal health.

The Texas Experiment Station (Bulletin 21, page 208), commenting on the effect of cotton-seed meal on pigs, says: "Some hogs resist the poison and are practically cotton-seed proof." So far as our experience has gone, most mature cattle are not attacked by this poisonous agent. The calf-feeding so far attempted with cotton-seed meal, has been terminated by death of the subject fed, though Rioter St. Helier doubtless had stoppage at the pylorus, which caused death. From these cases of cows and calves affected, apparently from the use of cotton-seed meal, it may be stated that for calves and some mature cows cotton seed meal, especially if old or damaged, is a dangerous food, though strong calves may be fed on it sparingly long enough to make veal of them with no apparent harm.

A PIG-FEEDING TEST.

[For a summary of this article, see Page 428.]

Shortly after putting the Station dairy in operation, it became necessary to purchase pigs to consume the skim-milk and buttermilk. A good Poland-China sow was purchased and bred to full Poland-China boar. Two pigs of this breeding (not less than seven-eighths Poland-China) have been fed in comparison with two cross-bred Poland-China and Jersey-Red pigs. The latter were purchased from a passing wagon. These were farrowed July 9, 1893. The grade pigs bred at the Experiment Farm were farrowed May 31, 1893. The older pigs were fed six to seven and one-half pounds of separated milk and three ounces of wheat bran per day on August 14, 15 and 16th. The younger pair were fed five pounds of the same milk and five ounces of wheat bran per day for the same time. All four pigs were weighed four mornings in succession. They were numbered 1 to 4, and named according to some distinguishing marks. On the morning of August 17 the average weights for each pair of pigs were as follows:

Grade pigs: Black or No. 1, $26\frac{9}{10}$ pounds; White Tail, No. 2, $23\frac{1}{4}$ pounds.

Cross-bred pigs: Spot, No. 4, $16\frac{3}{8}$ pounds; Red, No. 3, $17\frac{3}{4}$ pounds.

During the next nine days the food was slightly increased and the pigs weighed every day. Following are the weights of food and gain during this period:

TABLE IV.—Food Consumed and Gains in Weight of Young Pigs.

	FOOD CONSUMED.		GAIN IN WEIGHT (POUNDS.)	
	Separated Milk. Pounds.	Wheat bran. Ounces.	Total.	Average Daily.
Black, No. 1	98¾	41	9.76	1.08
White Tail, No. 2	96¾	41	9.25	1.03
Red, No. 3	66½	36	6.25	.69
Spot, No. 4	66½	37	4.96	.56

Numbers 1, 2 and 3 were males and were castrated. Then all were fed sixteen days with the following consumption of food and gains of live weight. The weights are always averages of three or more weighings before fed on the morning of as many successive days. The last weight is taken on the morning of the next period after the one for which the gains in weight are being determined:

TABLE V.—Showing Food Consumed and Gains in Weight of the same Pigs at a Later Period.

	FOOD CONSUMED.		GAIN IN WEIGHT (POUNDS).	
	Separated Milk. Pounds.	Wheat bran. Ounces.	Total.	Average Daily.
Black	243½	94.	17.3	1.08
White Tail	243½	94.	13.8	.86
Red	172½	60.	12.3	.77
Spot	172½	60.	11.3	.71

The operation did not check the daily gain of Black. Red gained faster after it, but White Tail's rate of gain was retarded, though he continued to gain faster than did the female, Spot. The pigs fully doubled in weight in twenty-five days.

At this point the record of food and gains was discontinued. The pigs were still kept in close pens and fed the milk that would otherwise have been wasted, some weeds or grass and bran. Later in the season we were asked by a correspondent about some combinations of foods for fattening pigs. The following rations to be mixed and fed to the limit of appetite were furnished. Wishing to observe the effect of the rations, these four pigs were fed on the same as given below in ten-day periods—that is, they were fed the first ration (proposed and being fed by our correspondent) ten days. The pigs were weighed on the mornings of the 9th, 10th and 11th days. A change of food was then made and the 11th day became the first of the second period on ration No. 2. Five rations were made and each was consecutively fed for a period of ten days. After feeding the five, they were again fed, in reverse order, for periods of ten days each. Then the fifth ration was fed during the eleventh period of ten days. This feeding began December 11th, 1893, and closed March 30th, 1894.

TABLE VI.—The Various Rations Fed to the Pigs During Ten-Day Periods.

	No. 1.		No. 2.		No. 3.		No. 4.		No. 5.	
	Lbs.	Per Cent.	Lbs.	Per Cent.	Lbs.	Per Cent.	Lbs.	Per Cent.	Lbs.	Per Cent.
Wheat bran	50	33⅓	50	28.57	100	20.0	75	27.27	100	28.57
Pea meal (cow-pea)	50	33⅓	50	28.57	50	20.0	50	18.18	50	14.29
Corn meal	50	33⅓	75	42.86	100	40.	150	54.54	200	57.14
Nutritive ratio according to usual calculation, 1:	4.76		5 25		5.5		6.0		6.25	
Weight of pig for which each ration was intended (pounds)	75		125		125 to 150		150 to 200		250	
*Value of grain mixture per 100 pounds	$1 163		$1.167		$1.137		$1.151		$1.154	

*The value of each mixture was obtained by adding the cost of grinding to the cost of corn and peas. Prices were: Wheat bran, $20 per ton; corn, 60 cents per bushel; peas, 70 cents per bushel; and for grinding, 12½ cents per 100 pounds.

The pigs were fed through the first trial by J. L. Chalmers, herdsman for a time during the summer of 1893. For the eleven subsequent periods the feeding was done by Mr. C. B. Foy, a special student, and Mr. W. C. Brogden, a freshman of the Agricultural and Mechanical College.

The design was to study these rations in the order given and again in reverse order. Hence the periods were made shorter than might have been done if more pigs had been available for this experiment.

Preparation of the Food.

What preparation should be given to food for pigs? In order to collect some data in reply to this query, the rations for these pigs were prepared as follows for the whole eleven periods:

Black. The food was mixed with hot water, used sparingly and allowed to stand from one feeding time to the next. Water was given in a separate trough whenever the pig seemed to need it.

White-Tail. Food sloppy from free admixture of cold water.

Red. Food dry. The feeding trough was fitted with two compartments the same as for the other pigs, but the *dry* food was kept dry while water was kept in the other end.

Spot. Food mixed with little cold water. The consistence about the same as Black's food. Water given as needed.

The rations, except milk, were weighed out to each pig in proportions to suit its appetite during the whole experiment. In addition to the grain ration, these pigs consumed the surplus separated (separator-skimmed) milk and buttermilk. The milk was divided between the pigs at every feed in proportion to their live weight at the beginning of each period, and was all consumed.

At first the milk and meal were fed three times daily. This gave too much stable work, and after the first period the noon feed with milk was dropped. Little meal was consumed at the noon feed, and that was dropped after the sixth period.

The following is a condensed summary of food consumed, weights of pigs, with gains by periods covering the whole time of 110 days:

TABLE VII.—Food Consumed by the Pigs during each Period.

Names of Pigs.	1st Period.		2d Period.		3d Period.		4th Period.		5th Period.		6th Period. Duplicate of 5th.		7th Period. Duplicate of 4th.		8th Period. Duplicate of 3d.		9th Period. Duplicate of 2d.		10th Period. Duplicate of 1st.		11th Period. Duplicate of 5th & 6th	
	Milk. Lbs.	Grain. Lbs.	Milk. Lbs	Grain. Lbs.	Milk. Lbs.	Grain. Lbs.	Milk. Lbs.	Grain. Lbs.	Milk. Lbs.	Grain. Lbs.	Milk. Lbs.	Grain. Lbs.	Milk. Lbs.	Grain. Lbs.	Milk. Lbs.	Grain. Lbs.	Milk. Lbs.	Grain. Lbs.	Milk. Lbs.	Grain. Lbs.	Milk. Lbs.	Grain. Lbs.
Red	115.19	56.25	118.75	76.25	161 25	65.5	138.88	73.25	120.3	69.0	104.06	56.0	108.88	47.0	103 25	40 0	122.3	38 0	113.1	34.0	114.43	28.0
Spot	144.13	63.50	148.75	91.00	188.06	77.0	170 19	86.00	152 25	76.0	130.88	76.0	152.85	58.0	126.38	80 0	155 9	78.5	145.5	63.5	152.65	60.0
White Tail	144.13	68 00	148.75	77.00	188 06	63.5	160.56	67.25	136.63	68 0	117.56	58.5	117.25	50.5	128.24	61.0	129.75	70.0	129.9	70.5	135.82	59.0
Black	158.43	70.25	163.50	90.50	215.13	77.0	181.69	75 50	152 25	80.0	137.12	80.0	132.69	60.5	132.83	74.0	156.17	85.5	151.1	80.5	161.49	72.0
Total	561 88	258.00	579 75	334.75	742.50	283.0	651.32	302.00	561 5	293.0	489.62	270 5	511.67	216.0	490.70	255.0	564 12	272.0	539.6	248.5	567.39	219.0

TABLE VIII.—Average Weights of Pigs at the Beginning of the Experiment, and at the end of each Ten-day Period, with the gain in Weight for each Period.

Names of Pigs.	Weight at Beginning of Experiment. Lbs.	End of 1st Period.		End of 2d Period.		End of 3d Period.		End of 4th Period.		End of 5th Period.		End of 6th Period.		End of 7th Period.		End of 8th Period.		End of 9th Period.		End of 10th Period.		End of 11th Period.	
		Live Wt. Lbs.	Gain Lbs	Live Wt. Lbs.	Gain Lbs.	Live Wt. Lbs.	Gain Lbs.	Live Wt. Lbs.	Gain Lbs.	Live Wt. Lbs.	Gain Lbs.	Live Wt. Lbs.	Gain Lbs.	Live Wt. Lbs.	Gain Lbs.	Live Wt. Lbs.	Gain Lbs.	Live Wt. Lbs.	Gain Lbs.	Live Wt. Lbs.	Gain Lbs.	Live Wt. Lbs.	Gain Lbs.
Red	75.5	96.2	20.7	118.0	21.8	132.7	14.7	151.0	18.3	162.7	11.7	178.5	15.8	188.8	10 3	197 0	8.2	212.7	15.7	218.3	5.6	220 7	2.4
Spot	96.5	121.2	24.7	144.3	23.1	164.0	19 7	185.7	21.7	201 7	16.0	222.2	20.5	232.5	10.3	253.7	21.2	264.7	11.0	279.7	15.0	282.7	3.0
White Tail	97.5	118.5	21.0	135.7	17.2	147.7	12.0	165.7	18.0	180.0	14.3	194.2	14.7	209.0	14.3	218.0	9.0	235.8	17.8	246.8	11 0	253 0	6.2
Black	105.0	132.3	27.3	154.6	22 3	171.7	17.1	190.7	19 0	207.3	16.6	226.3	19.0	238.7	12.4	254.7	16.0	279.8	25.1	291 2	11.4	297.5	6.3

From the method of calculating the milk to the live weight of the pigs, its effect should have been as near equal as possible on all the pigs; hence our interest centers on the amounts of the mixed grain required, in addition to the milk, to produce a given amount of gain in weight. These may be shown for each period in pounds of grain mixture required for one pound of gain in live weight, as follows:

TABLE IX.—Showing the Pounds of Milk and Grain Mixture Required to Produce One Pound of Gain in Weight During Each Period, and for Each Method of Preparing the Food.

		1st Period.	2d Period.	3d Period.	4th Period.	5th Period.	6th Period.
		lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Red (feed dry)	Separated or buttermilk,	5.56	5.45	10.97	7.59	10.29	6.60
	Grain mixture	2.71	3.50	4.46	4.00	5.90	3.54
Spot (feed mixed with little water).	Separated or buttermilk,	5.83	6.44	9.55	7.84	9.52	6.38
	Grain mixture	3.57	3.94	3.91	3.96	4.75	3.71
White-Tail (feed sloppy with cold water).	Separated or buttermilk,	6.86	8.65	15.67	8.92	9.55	8.00
	Grain mixture	3.24	4.77	5.29	3.74	4.76	3.98
Black (scalded with little water, mixed stiff).	Separated or buttermilk,	5.80	7.33	12.58	9.56	9.17	7.22
	Grain mixture	2.57	4.06	4.50	3.97	4.83	4.21

		7th Period.	8th Period.	9th Period.	10th Period.	11th Period.
		lbs.	lbs.	lbs.	lbs.	lbs.
Red (feed dry)	Separated or buttermilk,	10.57	12.59	7.79	20.20	49.75
	Grain mixture	4.56	4.88	2.42	6.07	12.17
Spot (feed mixed with little water).	Separated or buttermilk,	14.84	5.96	14.17	9.70	50.88
	Grain mixture	5.63	3.77	7.14	4.23	20.00
White-Tail (feed sloppy with cold water).	Separated or buttermilk,	8.20	14.25	7.29	11.81	21.90
	Grain mixture	3.53	6.78	3.93	6.41	9.51
Black (scalded with little water, mixed stiff).	Separated or buttermilk,	10.80	8.30	6.22	13.25	26.16
	Grain mixture	4.88	4.63	3.41	7.06	11.43

The least food required to gain one pound of live weight was during the first period, when the pigs were youngest and smallest. The same grain mixture fed, when they had grown to nearly three times the initial weight, was little more than half as effective in producing live weight as when there was less weight to be supported.

Comparing the gains from the different preparation of the grain food, it was found that where water enough was added to make the meal sloppy the gain was least, making cost in food greater per pound of live weight gained. There was more difference in the first five periods than during the last five. During the first five periods,

or fifty days, while the pigs were growing from an average weight of 93.6 pounds to an average of 205.2 pounds, the following weights of the mixed feed and milk was required to produce one pound of gain in live weight:

	Red.	Spot.	White-Tail.	Black.
Milk (pounds)	7.97	7.84	9.93	8.89
Grain mixture (pounds)	4.11	3.83	4.36	3.99
The gains in live weight for 50 days were (pounds)	87.2	105.2	82.5	102.3

During the second fifty days there was required for each pound of gain in live weight:

	Red.	Spot.	White-Tail.	Black.
Milk (pounds)	11.55	10.21	9.91	9.16
Grain mixture (pounds)	4.29	4.90	4.93	4.84
The gains in live weight were (pounds)	55.6	78.	66.8	84.

By combining the two periods in each ration as periods Nos. 1 and 10 on ration one, periods 2 and 9 on ration 2, etc., for all five rations, a mean is obtained which represents the average effect of each ration on the pig being fed in the earliest stage of the experiment, when the weight to be supported is least and the gain per pound of digested food most; and also in the last part of the experiment, when the weight is greater, and therefore more food is required for support and to produce one pound of gain. Carrying this out brings the average for each ration at the same average date for all the others. It also comes to the middle weight for the pigs, and gives as near an average between the rations in regard to these important relations as is possible to be obtained.

The following table, V, calculated from table V, expressed in terms of separated milk and of grain mixture required to produce one pound of gain in live weight, shows the relation of the five rations to each other. This is condensed in the fifth set of columns. This shows ration No. 2 to have produced one pound of gain for the least weight of food.

If reference is made to the earlier feeding when each of the pigs practically doubled in weight in twenty-five days, it will be noted that the pigs were on the same food, and were being fed, practically, *ad libitum*, and were consuming the same proportions of food as near as could be attained. This, while only an approximation, is sufficient to show that the individuality of the pigs was of small moment, and that the difference, shown in the bottom line of the table, may very reasonably be credited to the method of preparing the ration. In the table this has been marked "Difference credited to the preparation of food," and is the average of the five rations for each feed.

TABLE X.—Comparing Amounts of Rations Required for a Pound of Gain in Live Weight and Preparation of Foods.

	1. Red. Grain, dry		2. Spot. Food, Mix'd cold and stiff.		3. White-Tail. Food, mix'd cold and sloppy		4. Black. Food mixed stiff & hot, but left to cool		5. The rat'ns below produced 1 lb of gain in live w'ght for lbs.	
	Separated milk.	Grain mixture.	Separated milk.	Grain mixture.	Separated milk.	Grain mixture.	Separated milk.	Grain mixture.	Separated milk.	Grain mixture.
Ration 1	12.88	4.39	7.765	3.40	9.335	4.825	9.53	4.815	9.88	4.36
Ration 2	6.62	2.46	10.305	5.54	7.97	4.35	6.775	3.735	7.92	4.02
Ration 3	11.78	4 67	7.756	3.84	14.96	6.035	10.44	4.563	8.99	4.78
Ration 4	9 08	4.28	11.34	4.795	8.56	3.635	10.18	4.425	9.79	4.28
Ration 5	8.45	4.72	7.95	4.23	8.775	4.368	8.195	4.52	8.34	4.46
Difference credited to preparation of food	9.76	4.104	9.02	4.39	9.92	4.64	9.02	4.41		

By the comparisons shown in Table VI. it is seen that the sloppy food was more expensive than that mixed stiff with water, by requiring an additional pound of milk and one-fourth pound of mixed grain to produce a pound of gain in live weight. Thus, nearly 12 gallons of milk and 25 pounds of the mixed grain would be required in addition to make a gain of 100 pounds per pig. The scalded grain left to swell and cool from one feeding to the next, and that mixed at feeding time with cold water, gave results very similar to each other in respect to the amount required to make a pound gain of live weight. The dry grain mixture, with water to drink when needed, gave a pound of gain for the least amount of grain. This was 0.3 pound less than the mixed, either cold or hot, but 0.75 pound more of milk was required. This was the most economical feeding, not only in giving the greatest gain for a given amount of food, but in requiring the least preparation. The sloppy food was the most expensive.

It may also be noted that ration No. 2 produced 1 pound of gain, on the average of 2 periods for each one of the four pigs, at a considerable less cost of both milk and grain than any other. This ration consisted of wheat bran and cow-pea meal, 1 part each, mixed with $1\frac{1}{2}$ parts corn meal. The ratio calculated for it was 1 to 5.25, but the feeding with separated milk, which is relatively much richer in protein, would reduce that ratio considerably.

In order to show what could be realized on the milk fed, and at what stage of the feeding these pigs should have been turned into pork, the following form of statement has been calculated:

TABLE XI.—Showing Value Received for Separated Milk by 50-Day Period.

	Red. (Meal, Dry.)	Spot. (Wet, but stiff.)	WhiteTail. (Meal fed sloppy.)	Black. (Meal Scalded and Cooked Stiff like Spot's.)
For the first 50 days.				
Value of pig at beginning of experiment, at 4 cents per pound, live weight	$ 3.02	$ 3.86	$ 3.90	$ 4.20
Value of meal mixture fed at 1½ cent per lb.	3.71	4.42	3.86	4.42
Value of milk in ration (difference between cost and value of pig at end of 50 days)	1.40	1.81	1.24	1.74
Value of pig at end of 50 days (dressed weight, worth 6 cents, calculated to dress 83½ per ct)	8.13	10.09	9.00	10.36
Value received in cents per gallon of milk	1.72	2.03	1.27	1.60
For the second 50 days.				
Value of pig as above	8.13	10.09	9.00	10.36
Value of meal fed at 1½ cents	2.42	4.00	3.88	4.28
Value of milk in rations (calculated as above)	0.37	—0.10	—0.54	—0.08
Value of pig at end of 2d 50 days	10.92	13.99	12.34	14.56
Value of milk per gallon in cents	0.54			
Average value of milk for 100 day's feeding	1.13 cents per gallon.			

Thus it will be seen that a small price was realized for the milk during the first fifty days. This would have been slightly increased by including ten more days, as the pigs all made gains of 1.5 to over 2 pounds daily during the sixth ten-day period For the second fifty days, loss was incurred for all but the pig fed on dry meal, and on this one not quite half a cent per gallon for the milk fed was realized. Feeding after the sixty days was at a loss. The rations produced satisfactory gains of from 1.2 to nearly 2.5 pounds per day for six periods of ten days each. Attention is called to the advantage of the repetition of the fifth ration in the sixth period at the close of fattening. Repeating the other rations should not be followed in practice, though continuing each for a few days longer would doubtless prove desirable.

A SYSTEM OF FEEDING YOUNG CALVES.

[For a summary of this article, see Page 429.]

The substitution for the whole milk for food to young calves has been commonly practiced in dairy regions for a long time, nearly every feeder having his particular way to change to skim-milk, hay-tea, flax-seed gruel, etc. More care is necessary where the fat is so thoroughly extracted as by the use of a centrifugal separator.

The change from full to skimmed milk should not be made too hastily, and more careful provision for a proper supply of fat should be made. Several years ago, while feeding a fine herd of different breeds of cattle which was grown from calfhood, a series of rations to compass this change was calculated and successfully fed. It has since been used by this Station, with some variations following the general line of changes given in the following rations:

The milk upon which the calculation was made was not so rich in fat, nor was it skimmed as clean as centrifugal separator work. The change from feeding about one gallon of unseparated milk twice daily (calves are first taught to drink freshly drawn mother's milk at from one to four days old) is made by replacing one pint or pound of whole or unskimmed milk at a feed by the same weight of the skimmed milk. This gives a regular change, and fast enough for health of the calves. With the skim-milk a gruel was fed which was made of "old-process" linseed meal by using 2 ounces of the meal to 14 ounces of scalding-hot water, or 4 ounces to 28 of water, etc., according to the number of calves to be fed. Feeding one pound less of full milk and one more of skim-milk with one-fourth pound more of the gruel every successive feed makes the change complete in a few days if the calf does well. It should be closely watched, however, and the gruel varied according to its condition, and, if desirable, the change may be suspended for one or two days at different stages. A few ounces of ground oats and good fine hay should be kept within the calf's reach at all times until it eats both; then regular feeds should be supplied, the same as for milk and gruel. Fed in this way, a skim-milk-fed calf may be grown up as fine and at less cost than if fed upon unskimmed milk.

It will be observed that these rations differ from the standard and that the ratio is narrower. 1st. The rations are successfully nourishing the calf long before it has reached the age named in the standard; 2d. The narrow ratio will be widened in practice by the calf's eating some of the hay and ground oats. Wheat bran or corn meal may be added in small amounts later, but not in sufficient amount to derange digestion. A little green food can be offered if

it can be supplied; or in spring and summer the calves can be turned into a small grass, clover or shady pasture. Slight derangements of digestion can be handled by reducing amount of feed or by adding a small amount (one tablespoonful) of lime water to each feed.

TABLE XII.—Rations fed to Calves during Four Stages with Digestible Nutrients.

	Total Dry Matter, Lbs.	DIGESTIBLE.			Nutritive Substance Lbs.	Ratio. 1 to
		Protein. Lbs.	Carbo-hydrate Lbs.	Fat. Lbs.		
First Ration.						
12 pounds whole milk	1.56	.486	.546	.456		
4 pounds skimmed milk	.40	.14	.20	.028		
2 ounces O. P. linseed meal	.113	.032	.033	.009		
Total	2.073	.658	.779	.493	1.930	3.06
Second Ration.						
8 pounds whole milk	1.04	.324	.364	.304		
8 pounds skimmed milk	.80	28	.400	.056		
4 ounces O. P. linseed meal	227	.064	.066	.018		
Total	2.067	.668	.83	.378	1.876	2.6
Third Ration.						
4 pounds whole milk	.52	.162	.182	.152		
12 pounds skimmed milk	1.20	.42	.60	.084		
6 pounds O. P. linseed meal	.341	.096	.099	.027		
Total	2.061	.678	.881	.263	1.822	2.7
Fourth Ration.						
16 pounds skimmed milk	1.60	.56	.80	.112		
8 ounces O. P. linseed meal	.454	.128	.132	.036		
Total	2.054	.688	.932	.148	1.768	2 nearly

The change of ration for a calf was calculated in four stages, which are given above. These can be relied on where the separator is *not* used. The chief difference between "skimmed" and "separated" milk is in the fat, the "separated" milk contains only about one-third as much as the skimmed milk; therefore, where the separator is used, more linseed meal gruel will be needed to balance the ration.